PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-268970
(43)Date of publication of application : 28.09.2001

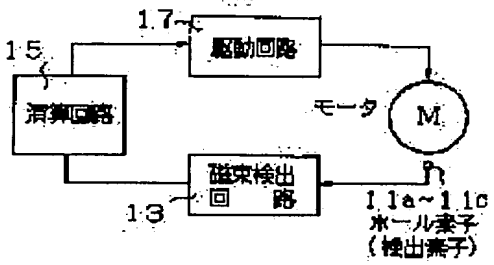
(51)Int.Cl. H02P 6/10

(21)Application number : 2000-080421
(22)Date of filing : 22.03.2000

(71)Applicant : SANYO ELECTRIC CO LTD
KUMAGAYA SEIMITSU KK
(72)Inventor : KANAMORI JUNICHI

(54) DRIVING AND CONTROLLING METHOD FOR THREE-PHASE FULL- WAVE MOTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To suppress vibration and reduce noise even in a motor that obtains large torque.
SOLUTION: A magnetic flux detection circuit 13, together with Hall elements 11a to 11c placed in the motor M, detects the magnetization waveform of the rotor magnet. An arithmetic circuit 15 produces driving current waveform sustained through 120° in phases U, V, and W, and, based on the detected magnetization waveform corresponding to phases U, V, and W, calculates such driving current waveform that the rotational torque of the motor M in each phase will be constant in blocks of 60°. Based on this driving current waveform, a driving circuit 17 changes the driving coil of the motor to be energized.



LEGAL STATUS

[Date of request for examination]	11.06.2003
[Date of sending the examiner's decision of rejection]	28.09.2004
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the drive control approach of the three-phase-circuit full wave motor which carries out drive control of the three-phase-circuit full wave motor The magnet magnetization wave of each phase at the time of rotation is detected, and it is within the section for 60 degrees of every electrical angles. The drive control approach of the three-phase-circuit full wave motor characterized by calculating the drive current wave form of each phase where compound with said detection magnetization wave of each phase, and fixed torque is acquired, passing a drive current to the drive coil of each phase based on these operation drive current wave form, and carrying out drive control of said motor.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the drive control approach of a three-phase-circuit full wave motor, and it is related with the possible drive control approach of suppressing the noise and vibration in the motor by which big running torque is obtained especially.
[0002]
[Description of the Prior Art] If the three-phase-circuit brushless motor of an inner rotor mold is conventionally made into an example, the configuration is shown in drawing 4 .
[0003] Namely, six cylindrical salient pole gear-teeth 3a of U phase from the inside of the telescopic stator magnetic core 1, V phase, and W phase, Turn 3b and 3c to the center of rotation, and it is made to protrude by turns. Each salient pole gear teeth 3a and 3b, The width of face of the addenda 5a, 5b, and 5c of 3c is expanded to a hoop direction. These salient pole gear-tooth 3a, Drive coil 7a which is equivalent to U phase, V phase, and W phase by using 3b and 3c as a winding core, It is the configuration which it comes to arrange the Rota magnet 9 which rolled 7b and 7c, made it telescopic in the cylindrical dead air space formed inside with these addenda 5a, 5b, and 5c, and magnetized N pole and the south pole by turns to the hand of cut, enabling free rotation. In addition, although drawing 4 was a cross-sectional view, illustration of the slash which shows a cross section was omitted.
[0004] Such a three-phase-circuit brushless motor M For example, ****** each salient pole gear-tooth 3a, The addenda 5a and 5b of 3b and 3c, three hall device 11for location detection a arranged among 5c, The Rota magnet 9 rotates by predetermined running torque by 11b and 11c detecting the rotation location of the Rota magnet 9, and carrying out change energization of the drive coils 7a, 7b, and 7c of U phase, V phase, and W phase in the drive circuit which is not illustrated based on this location detection timing.
[0005] and in such a brushless motor M Earle (R) is formed in the addenda 5a, 5b, and 5c of each salient pole gear teeth 3a, 3b, and 3c. A skew is given to the magnetization wave of the Rota magnet 9. Each salient pole gear-tooth 3a, While enlarging opening spacing between the addenda 5a, 5b, and 5c of 3b and 3c, and the Rota magnet 9 With these combination, generating of the vibration at the time of rotation is suppressed small, and sine-wave-izing the drive current which carries out change energization to the drive coils 7a, 7b, and 7c of U phase, V phase, and W phase etc. can lessen the noise.
[0006] On the other hand, in such a brushless motor M, while enlarging the magnetization energy product of the Rota magnet 9, squaring of the magnetization wave is carried out. While making small the addenda 5a, 5b, and 5c of each salient pole gear teeth 3a, 3b, and 3c, and spacing of the opening formed between the Rota magnets 9, if carrying out squaring of the drive current wave form which carries out change energization to drive coils 7a, 7b, and 7c etc. combines these, it turns out that running torque can be increased.
[0007]
[Problem(s) to be Solved by the Invention] However, since running torque is increased in such a brushless motor M as mentioned above Enlarge the magnetization energy product of the Rota magnet 9, or squaring of the magnetization wave is carried out. If squaring of the drive current wave form to drive coils 7a, 7b, and 7c is carried out while narrowing the addenda 5a, 5b, and 5c of each salient pole gear teeth 3a, 3b, and 3c, and the opening between the Rota magnets 9 Vibration becomes large at the time of rotation of the Rota magnet 9, there is a difficulty that the noise increases, and increase of running torque and control of the noise conflict mutually constitutionally.
[0008] While it was made in order that this invention might solve such a conventional technical problem, and big running torque is obtained, vibration and the noise are also aimed at offer of the drive control

approach of the three-phase-circuit full wave motor which can be stopped small.
[0009]
[Means for Solving the Problem] In the drive control approach of a three-phase-circuit full wave motor that this invention carries out drive control of the three-phase-circuit full wave motor in order to solve such a technical problem The magnet magnetization wave of each phase at the time of rotation is detected, and it is within the section for 60 degrees of every electrical angles. The drive current wave form of each phase where compound with the detection magnetization wave of each phase, and fixed torque is acquired is calculated, and the approach of passing a drive current to the drive coil of each phase based on these operation drive current wave form, and carrying out drive control of the above-mentioned motor is offered.
[0010]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. In addition, the same sign is given to the part which is common for the conventional example.
[0011] Drawing 1 is the block diagram showing the drive control circuit which enforces the drive control approach of the three-phase-circuit full wave motor concerning this invention.
[0012] As shown in drawing 4 which the full wave motor M of a three phase circuit has a well-known configuration conventionally, for example, was mentioned above in drawing 1 A total of six cylindrical salient pole gear-teeth 3a which corresponds to U phase, V phase, and W phase from the inside of the telescopic stator magnetic core 1 which consists of the magnetic substance, 3b and 3c protrude towards the center of rotation. Addendum 5a of each salient pole gear teeth 3a, 3b, and 3c, Drive coil 7a by which width of face can extend to a hoop direction, and 5b and 5c are equivalent to U phase, V phase, and W phase, The salient pole gear teeth 3a, 3b, and 3c are wound around 7b and 7c as a winding core. These addenda 5a, The Rota magnet 9 which made it telescopic and was magnetized by turns in N pole and the south pole by 5b and 5c by four poles of dead air space of the shape of a cylinder formed inside in the hand of cut is arranged free [rotation], and has brush loess composition of 4 pole 6 slot.
[0013] Between the addenda 5a and 5b of ****** each salient pole gear teeth 3a, 3b, and 3c like a semicircle, and 5c, three location sensing elements 11a, 11b, and 11c which detect the rotation location, for example, hall devices, are arranged at intervals of 60 degrees per every piece towards the Rota magnet 9 from the magnetization condition of the Rota magnet 9.
[0014] The hall devices 11a, 11b, and 11c which returned to drawing 1 and have been arranged at Motor M are connected to the magnetic-flux detector 13.
[0015] This magnetic-flux detector 13 carries out functional actuation with hall devices 11a, 11b, and 11c. Change of the magnetic-flux condition (N pole / south pole) formed near the tip of hall devices 11a, 11b, and 11c with rotation of the Rota magnet 9 is detected. For example, as shown in drawing 3 A, while carrying out the detection output of the magnetization wave of U phase, the rotation location of the Rota magnet 9 is detected from the changing point of plus/minus of a detection magnetization wave etc., and it is a change timing signal (it does not illustrate.). It outputs and connects with the arithmetic circuit 15.
[0016] Here, the wave of V phase itself is mutually the same 240-degree progress or only by 120 degrees being overdue to U phase.
[0017] The wave of V phase shown in drawing 3 B (reversal) is illustrated where 180 degrees of waves of actual V phase are reversed. This wave is formed in an arithmetic circuit 15. In addition, (reversal) of V (reversal) phase is as meaning phase inversion and being correctly shown in drawing 3 . It is below the same.
[0018] Moreover, although the detection magnetization wave of W phase is not illustrated by drawing 3 , 120 degrees of phases progress to U phase, or 240 degrees is only overdue so that it may be well-known, and the wave itself is mutually the same.
[0019] Furthermore, when magnetization is N pole, + (plus) output is obtained, and as for the magnetic-flux detector 13, - (minus) output is obtained at the time of the south pole.
[0020] An arithmetic circuit 15 forms the drive current wave form of U (reversal) phase, V (reversal) phase, and (reversal) W phase in U phase which starts and carries out 120-degree section continuation with a change timing signal, V phase and W phase, and a list, and the microcomputer containing CPU, ROM, RAM, etc. is formed in the subject, and it is connected to the drive circuit 17. The detailed function about the drive circuit 17 is mentioned later.
[0021] In addition, it is the wave which reversed 180 degrees of waves of actual U phase and W phase about U (reversal) phase and (reversal) W phase as well as V (reversal) phase.
[0022] As the drive circuit 17 has a well-known configuration conventionally, for example, shows it to

drawing 2 , the emitter of the NPN power transistor Q1, and the collector of the NPN power transistor Q4 While carrying out series connection of the emitter of the NPN power transistor Q3, and the collector of the NPN power transistor Q6 respectively, the emitter of the NPN power transistor Q2, and the collector of the NPN power transistor Q5 The collector of transistors Q1, Q2, and Q3 is connected to the plus side of a power source E, and the emitter of transistors Q4, Q5, and Q6 is connected to the minus side of a power source E, and it has the circuit which comes to carry out parallel connection of these series circuits to a power source E, and is constituted.

[0023] The node of the transistors Q1 and Q4 of the drive circuit 17 is connected to the end of drive coil 7a of U phase of Motor M. The node of transistors Q2 and Q5 is connected to the end of drive coil 7b of V phase. it connects with the end of drive coil 7c of W phase, and the other ends of the drive coils 7a, 7b, and 7c of U phase, V phase, and W phase make common connection of the node of a transistor Q3 and a transistor Q6 -- having -- each drive coils 7a, 7b, and 7c -- being the so-called -- the star is carried out.

[0024] In addition, the dot in the drive coils 7a, 7b, and 7c of U phase in drawing 2 , V phase, and W phase shows these cut waters.

[0025] In drawing 1 mentioned above, hall devices 11a, 11b, and 11c, the magnetic-flux detector 13, the arithmetic circuit 15, the drive circuit 17, and Motor M are connected from on expedient in one Rhine.

[0026] In practice, as shown in drawing 4 , while three hall devices 11a, 11b, and 11c are arranged at Motor M, it connects in Rhine applicable to U phase, V phase, and W phase between hall devices 11a, 11b, and 11c, the magnetic-flux detector 13, the arithmetic circuit 15, the drive circuit 17, and Motor M.

[0027] Next, the process in which actuation of the drive control circuit shown in drawing 1 is explained explains the drive control approach of the three-phase-circuit full wave motor concerning this invention.

[0028] Although wave-like illustration of W phase is omitted in the following explanation of operation, as mentioned above, it is the same 120-degree progress or only by 240 degrees being overdue to U phase, and the wave of V phase itself is the same 240-degree progress or only by 120 degrees being overdue to U phase.

[0029] If a change timing signal is outputted while the magnetic-flux detector 13 outputs the detection magnetic-flux wave of U phase like drawing 3 A in drawing 1 based on the detecting signal from the hall devices 11a and 11b equivalent to U phase and V phase An arithmetic circuit 15 creates V (reversal) phase signal which reversed 180 degrees of actual V phase signals, forms the drive current wave form which shifts 60 degrees, and starts and carries out 120-degree section continuation mutually, and outputs it to the drive circuit 17.

[0030] The drive circuit 17 with transistors Q1-Q6 Drive coil 7a of U phase, V phase, and W phase, Change energization of 7b and the 7c is respectively carried out by every 120-degree 120-degree delay. A drive current The transistors Q1-Q6 from the plus (+) side of a power source E, U phase, It passes along the drive coils 7a, 7b, and 7c of V phase and W phase, and flows to the minus (-) side of a power source E in the following six-kind path, and the Rota magnet 9 rotates.

[0031] If motor torque is fixed in 60 degrees, in other range, it becomes fixed that the Rota magnet 9 rotates in six kinds of paths, and it can make torque regularity throughout 360 degrees.

[0032] Namely, according to the connection of drive coils 7a, 7b, and 7c, the drive current of U phase, V phase, and W phase flows from the cut water of drive coils 7a, 7b, and 7c, and, as for the drive current of U (reversal) phase, V (reversal) phase, and (reversal) W phase, a current flows toward the cut water of drive coils 7a, 7b, and 7c.

[0033]

Power-source E+ side -> Q1 -> U phase -> (reversal) V phase -> Q5 -> power-source E- side 0-60 degrees Power-source E+ side -> Q1 -> U phase -> (reversal) W phase -> Q6 -> power-source E- side 60-120 degrees Power-source E+ side -> Q2 -> V phase -> (reversal) W phase -> Q6 -> power-source E- side 120-180 degrees Power-source E+ side -> Q2 -> V phase -> (reversal) U phase -> Q4 -> power-source E- side 180-240 degrees Power-source E+ side -> Q3 -> W phase -> (reversal) U phase -> Q4 -> power-source E- side 240-300 degrees Power-source E+ side -> Q3 -> W phase -> (reversal) V phase -> Q5 -> power-source E- side 300-360 degrees [0034] general -- a motor -- running torque -- T [N-m] and a pole -- P and magnetic flux -- phi [Wb] and a conductor -- if a number is set to Z and a drive current is set to I [A], running torque T can be expressed as follows.

T=P-phi-Z-I [0035] here -- a pole P and a conductor -- it carries out, and since the number Z is fixed, when [which either magnetic flux phi or the drive current I fluctuated] running torque T will be proportional to the product (T=phi-I) of magnetic flux phi and the drive current I, if another side is made to ****, running torque T will become fixed.

[0036] Then, in the arithmetic circuit 15 of drawing 1 , when V (reversal) phase waves which carried out 180-degree reversal operation of the detection magnetization wave of U phase and V phase magnetization wave which were detected by hall devices 11a, 11b, and 11c by the arithmetic circuit 15 are drawing 3 A and B, this wave is measured at the space point which had a certain distance from the magnet by the hall device, and it can be considered that it is a magnetic-flux wave and approximation.
[0037] Then, in the arithmetic circuit 15 of drawing 1 , so that the running torque of U phase and (reversal) V phase may become fixed, as shown in these drawings E and F If operation formation of the drive current wave form of U phase as shown in these drawings C and D, and (reversal) V phase (reversal) (V phase current is a current of V phase and the opposite sense) is carried out and it outputs to the drive circuit 17, as shown in this drawing G, the synthetic running torque of U phase and (reversal) V phase will become fixed in the 60-degree section.
[0038] This was mentioned above. Power-source E+ side -> Q1 -> U phase -> (reversal) V phase -> Q5 -> power-source E- side It is equivalent to 0-60 degrees.
[0039] Similarly, as running torque becomes fixed also with W phase, if a drive current wave form is calculated and it outputs to the drive circuit 17, the synthetic running torque of U phase, W interphase, and V phase and W interphase will become fixed, and torque will become fixed in the 360-degree continuation section in an arithmetic circuit 15 at the time of the rotation drive of a motor.
[0040] An arithmetic circuit 15 carries out operation formation of the drive current wave form which becomes fixed in the section whose running torque of each phase in Motor M is 60 degrees based on the detection magnetization wave applicable to these U phase, V phase, and W phase, and should just have the function outputted to the drive circuit 17.
[0041] The gestalt of operation mentioned above is an example, and a magnetization sensing element is not limited to hall devices 11a-11c, either, and the formation configuration of drive coils 7a-7c may also be a delta connection, and it is not limited [although illustration is not carried out, you may be a sensing coil and] to the configuration which also mentioned the drive circuit 17 above.
[0042] And if it can carry out with the configuration which has the stator magnetic core which has three or more salient pole gear teeth, and the configuration which has three or more air core drive coils, without having a stator magnetic core and the Rota magnet also uses the thing of two or more poles in addition to the configuration of a motor M like drawing 4 mentioned above in this invention, the purpose achievement of this invention is possible.
[0043] But it attains [wind the drive coil of the plane 1 of the three phase circuits around each salient pole gear tooth of the stator magnetic core of 3n (n is one or more integers) individual, since it becomes possible if it is made the configuration which combined the Rota magnet of 4n (n is one or more integers) pole to make the salient pole width of face and magnet **** of a salient pole gear tooth into 180 degrees, can carry out the maximum activity of the torque, and / the maximum activity of use magnetic flux] and is desirable.
[0044] Furthermore, the configuration of Motor M is also widely applicable to an outer rotor mold or a flat-surface opposed type.
[0045]
[Effect of the Invention] The drive control approach of the three-phase-circuit full wave motor applied to this invention as explained above The magnet magnetization wave of each phase at the time of rotation is detected, and it is within the section for 60 degrees of every electrical angles. The drive current wave form of each phase where compound with the detection magnetization wave of each phase, and fixed torque is acquired is calculated. Since a drive current is passed to the drive coil of each phase based on these operation drive current wave form Even if it carries out carrying out squaring of the drive current wave form which enlarges the magnetization energy product of the magnet which forms a motor, or carries out squaring of the magnetization wave, narrows the opening between a stator and Rota, and carries out change energization to a drive coil etc. and aims at increase of running torque It becomes possible to suppress vibration small and to decrease the noise, and there is an advantage which can attain both increase of running torque and oppression of the noise to coincidence.

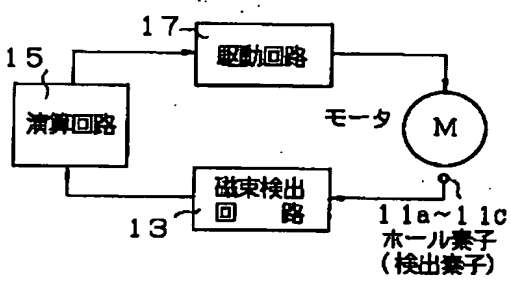
[Translation done.]

* NOTICES *

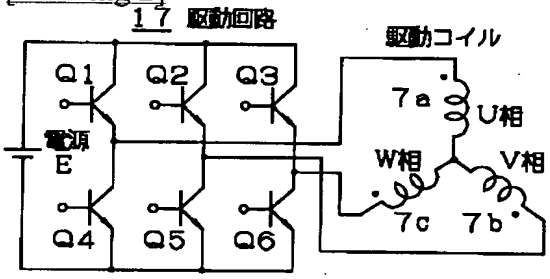
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

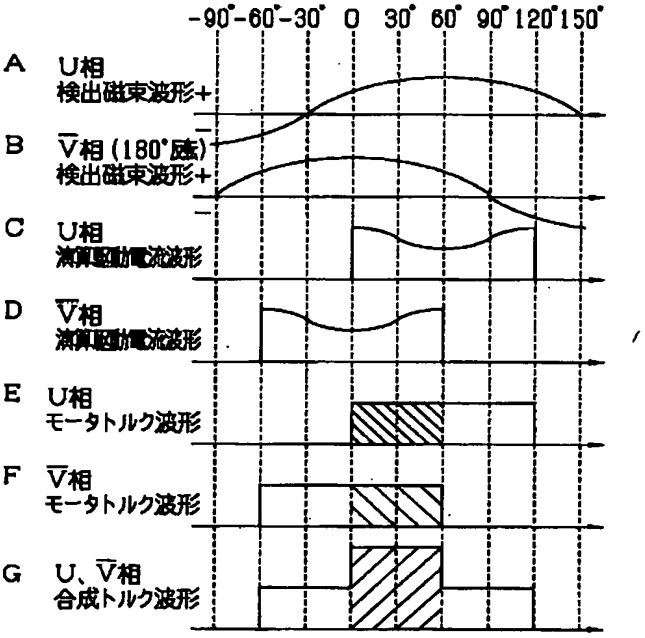
[Drawing 1]



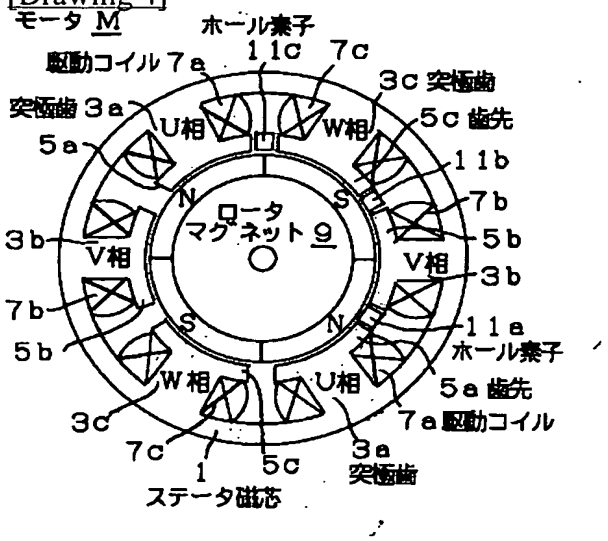
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]